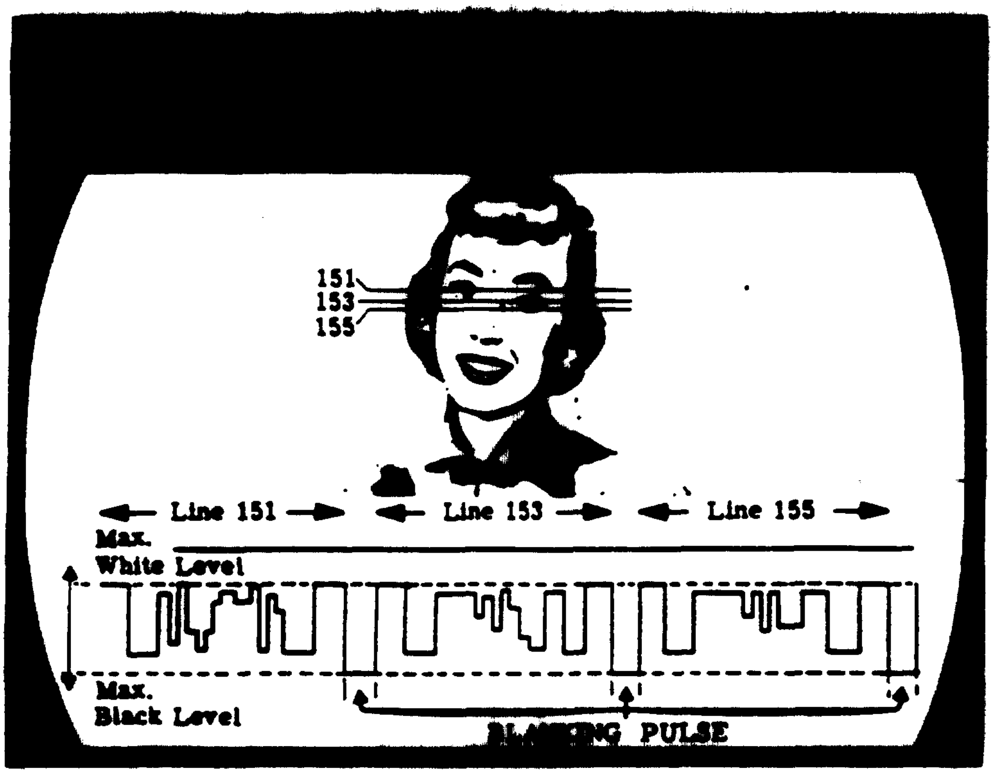
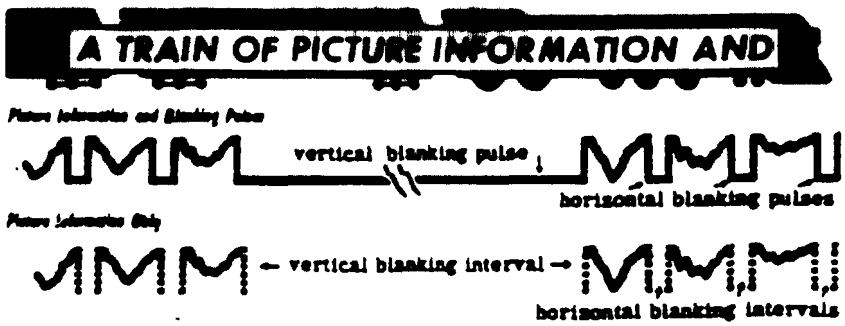
Adding the Blanking Pulses to the Picture Signal (contd.)

Adding the blanking voltage pulses to the picture signal fills the gap, labeled earlier the no-picture-signal-interval, between the end of one horizontal line of picture information and the beginning of the next line. We



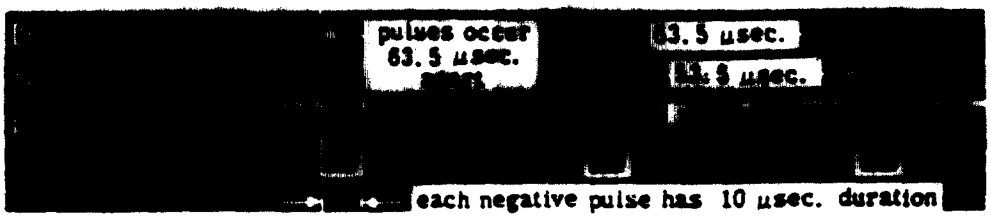
illustrated the results of only three lines of picture information. Here we show the same three lines with the blanking pulses added. Continuous scanning of field after field results in a signal consisting of an unending series of picture information voltages followed by blanking voltage.



BLANKING PULSE VOLTAGES

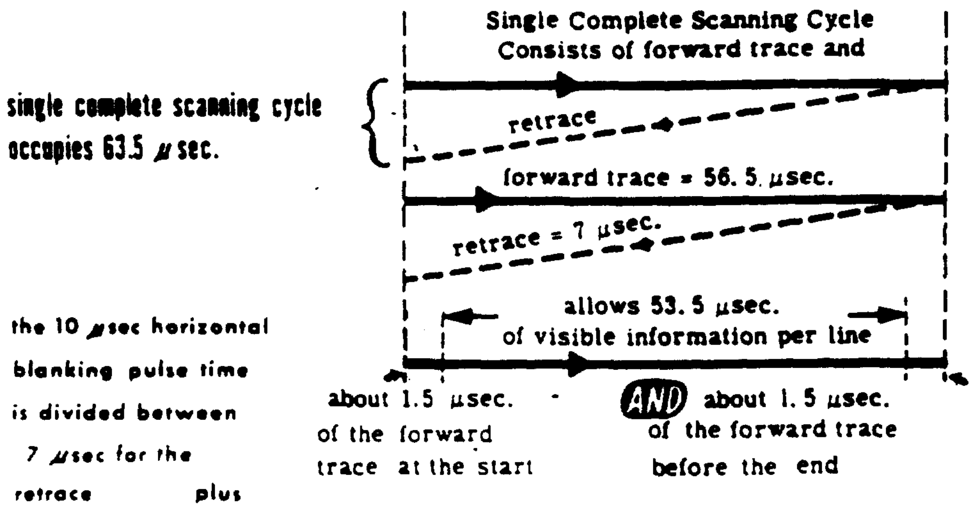
Details of Horizontal Blanking Pulses

Before concluding the discussion of blanking pulses, it might be well to detail the constants and action of the horizontal blanking pulse. The conditions of its use are of special interest, and are not evident simply by observation of the scanning lines that make up the fields.

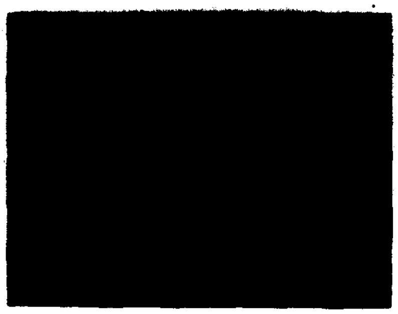


In line with the constants shown above the distribution of the horizontal blanking time is the following:

DISTRIBUTION OF HORIZONTAL BLANKING TIME



The blanking of the horizontal scan for the short intervals after it begins and before it ends is not the same in the camera tube as in the monitor and receiver picture tubes. The horizontal blanking pulse delivered to the camera tube is slightly shorter in duration than that which is combined with the signal. This is a safety measure to assure that the beam is in the proper position before the delivery of picture information begins. The slight loss in picture content because of the extended horizontal blanking time is inconsequential, as is the picture content lost by the complete blanking of a number of horizontal scanning lines.

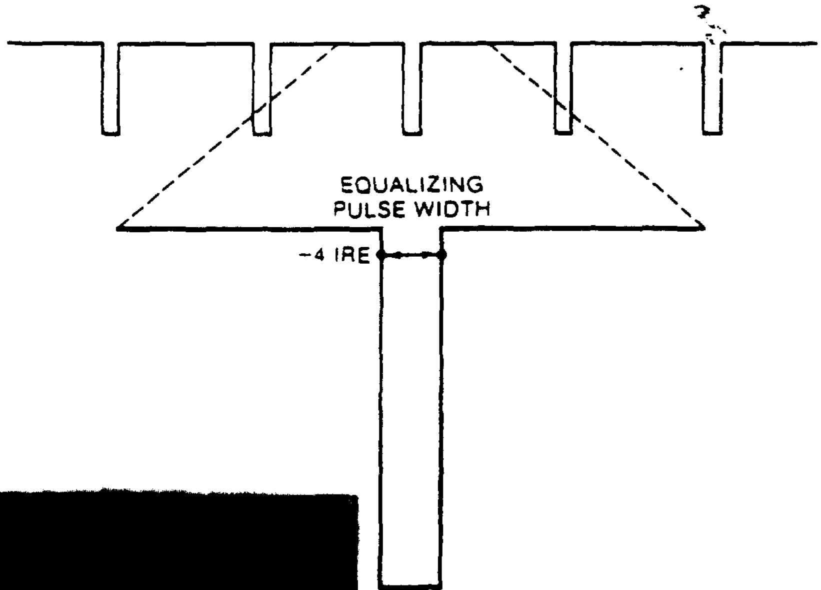


Vertical Blanking

Vertical blanking is the time between the last picture information at the bottom of one field and the first picture information at the top of the following field. Vertical blanking is measured from the leading edge of the first equalizing pulse. Measured in terms of time, vertical blanking must be greater than 1.17 milliseconds, but less than 1.33 milliseconds. In terms of scanning lines, the maximum vertical blanking is 21 lines. It is fairly standard in the industry to adhere to 21 lines of blanking, as the vertical interval lines preceding picture are often used for the transmission of vertical interval test signals.

Equalizing Pulse Width

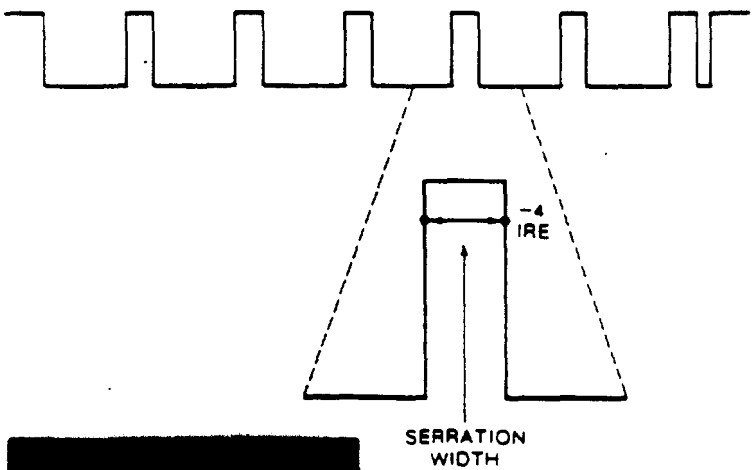
The width of the equalizing pulses which precede and follow vertical sync should be 2.54 microseconds. The tolerance on equalizing pulses is that the area of the pulse must be between 45 and 50% of the area of a synchronizing pulse. It is a fairly simple matter to compare the relative widths of the pulses and make a valid comparison in that manner. The equalizing pulses can be viewed on a waveform monitor by using the variable line selector to trigger in the vertical interval. Be sure when making this measurement that the vertical interval is correctly formatted as described previously.



11. Measured between points at the 1/10 sync (-4 IRE) level. Shown here at 0.25 μsec/div: 2.40 μsec. Depending on the width of H sync, equalizers may be between 2.0 and 2.54 μsec.

Vertical Sync Pulse

The vertical sync pulse should have a total width equal to three horizontal scanning lines. The serrations in the sync pulse must be between 3.8 and 5.1 microseconds, measured at the -4 IRE level. The rise and fall times of the equalizers and serrations must be less than 0.250 microseconds.

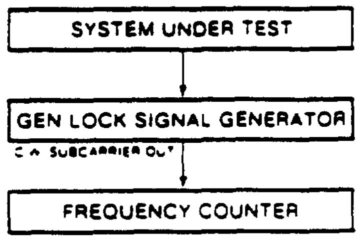


12. 3 full lines in duration, with serrations as shown here. 0.5 μsec/div, serration width = 4.5 μsec.

Subcarrier Frequency

The frequency of the color subcarrier or burst signal must be held within 10 Hz of 3.579545 MHz. The short time duration of the burst signal makes direct frequency counting quite inaccurate. Depending on the equipment available, burst frequency can be measured or verified in several ways.

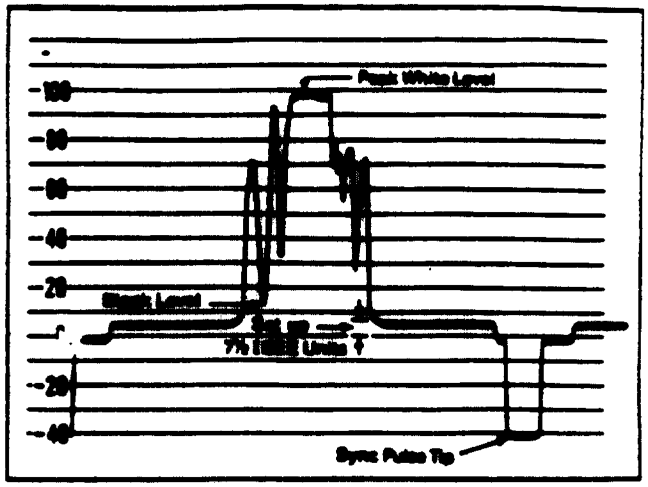
Frequency Counter and Gen-Lock Device



If you have a digital frequency counter and a gen-lock signal generator with a cw subcarrier output, the generator can be locked to the video signal and the subcarrier frequency of the generator can be measured with the frequency counter.

17. What is the meaning of the term waveform?

A. A waveform is the graphic representation of an electromagnetic wave showing the variations in its amplitude with time. An oscilloscope provides these graphic representations in the form of luminous patterns on the face of the cathode ray tube.



Waveform Graticule Scale with Single Trace

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18. How is the waveform monitor calibrated?

A. A standard of the Electronics Industries Association* (EIA) specifies that the total excursion of the composite video signal shall not exceed 1.0 volt from the tips of the sync signal to the reference white level. By means of an accurate internal calibrating voltage, the vertical deflection of the electron beam in the oscilloscope can be adjusted to fill the waveform scale. When the reference voltage is replaced with a video signal, the amplitude of tha signal can be estimated with considerable accuracy from the positions on the scale of the waveform display. In the initial adjustment of a waveform monitor, blanking level is first set at zero on the scale by adjusting the vertical position of the display. Then the tips of the sync pulses should just touch the -40 line on the scale.

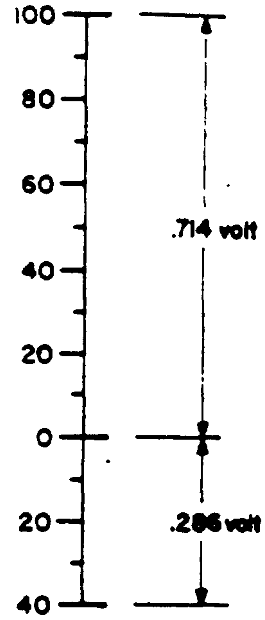
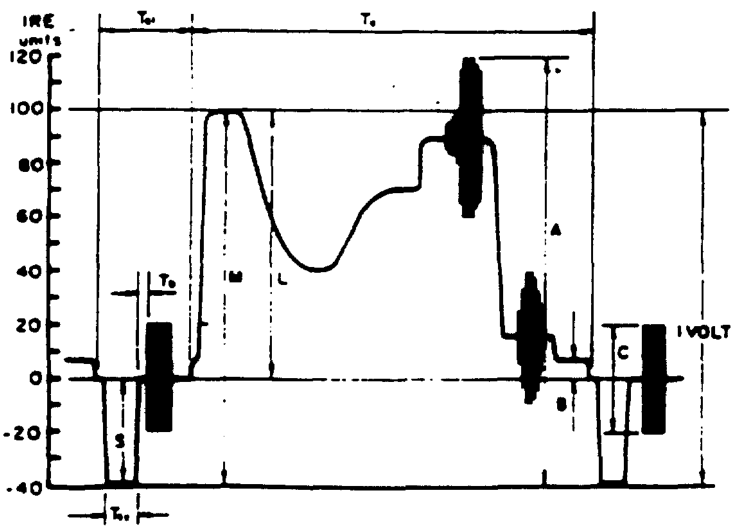


Fig. 1. The IRE scale units.
(For a 1V P-P composite signal)



WAVEFORM TERMINOLOGY

- A: The peak-to-peak amplitude of the composite color video signal
- B: The difference between black level and blanking level (set-up)
- C: The peak-to-peak amplitude of the color burst
- L: Luminance signal—nominal value
- M: Monochrome video signal peak-to-peak amplitude (M = L + S)
- S: Synchronizing signal—amplitude
- T_b: Duration of breezeway
- T_{bl}: Duration of line blanking period
- T_{sy}: Duration of line synchronizing pulse
- T_a: Duration of active line period

The standard composite color video signal.

19. Is black level the same as blanking level?

A. In North American television there is a space, nominally 7½ IEEE units in the composite video signal, between blanking level and the black peaks in the picture signals. This is known as setup. Normally the lowest levels in the picture signals, representing shadow areas, are adjusted to just touch the setup level.

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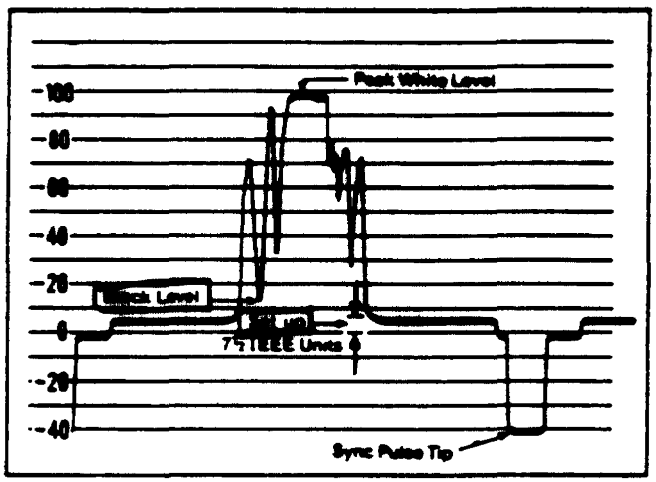
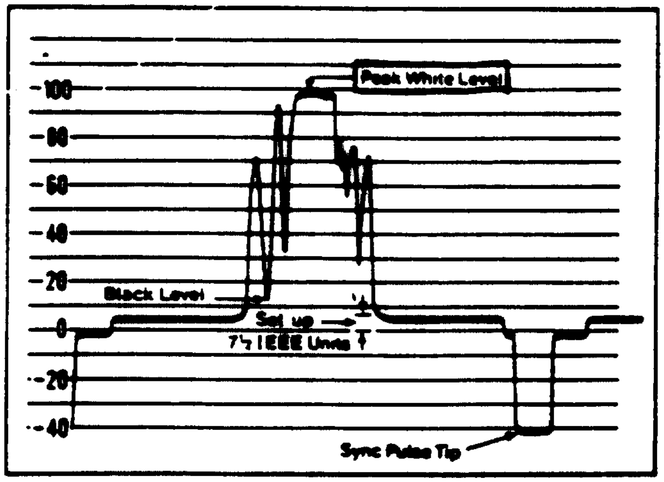
* Electronics Industries Association, 2001 Eye Street, N.W., Washington, D.C. 20006.



Waveform Graticule Scale with Single Trace composite video signal contains all of the elements necessary for transmission to the audience — picture signals, sync pulses, blanking pulses, setup, etc. However, the television station often displays the picture signals on the waveform monitors without sync pulses or setup.



Waveform Graticule Scale with Single Trace

COMPOSITE VIDEO SIGNAL

WAVEFORM

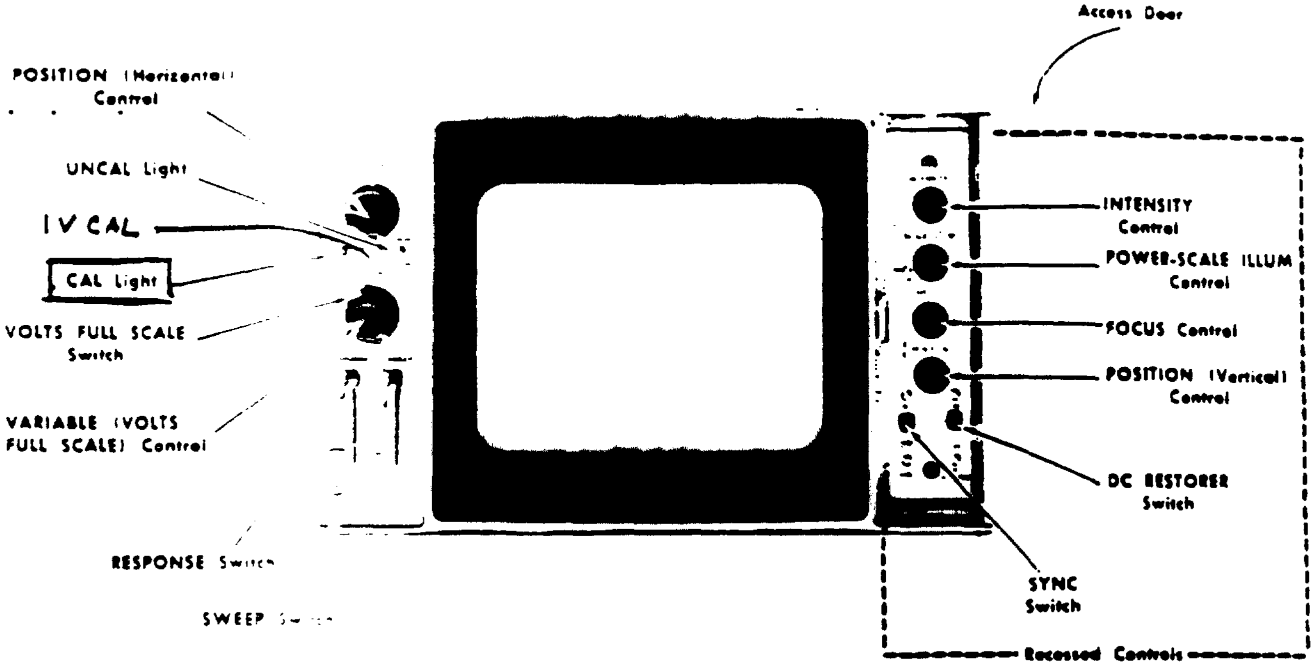


Fig. 2-2. Typical calibrator waveform display obtained when the VOLTS FULL SCALE switch is set to 1 V CAL, the VARIABLE VOLTS FULL SCALE control is set to CAL and the display is properly focused.

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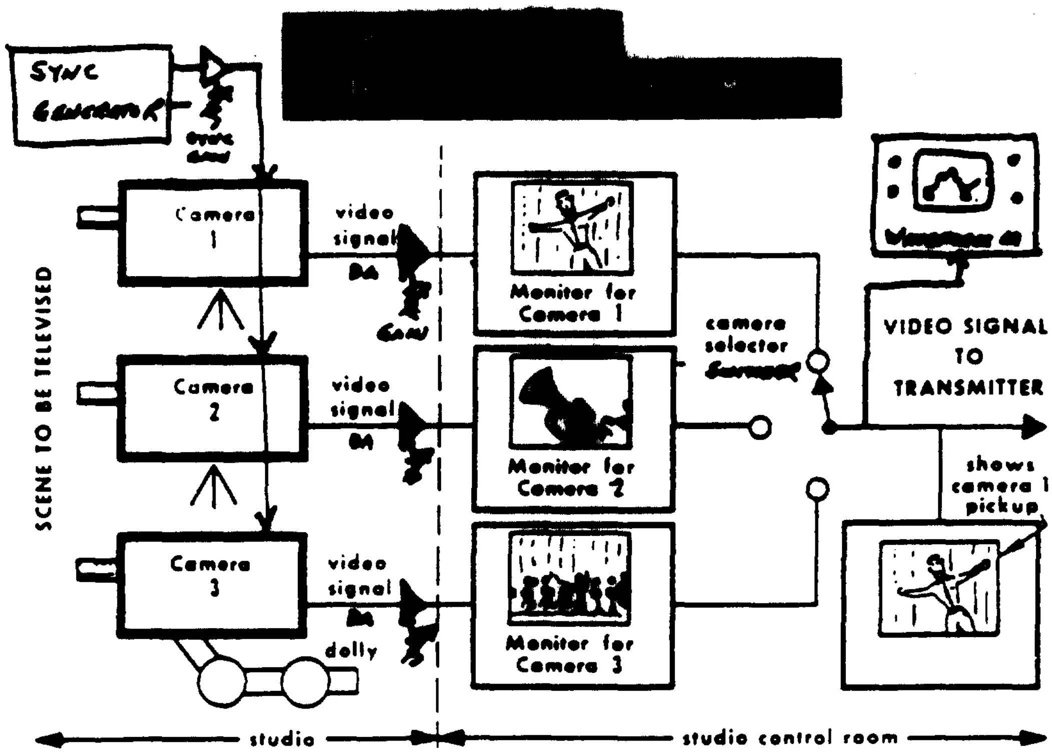
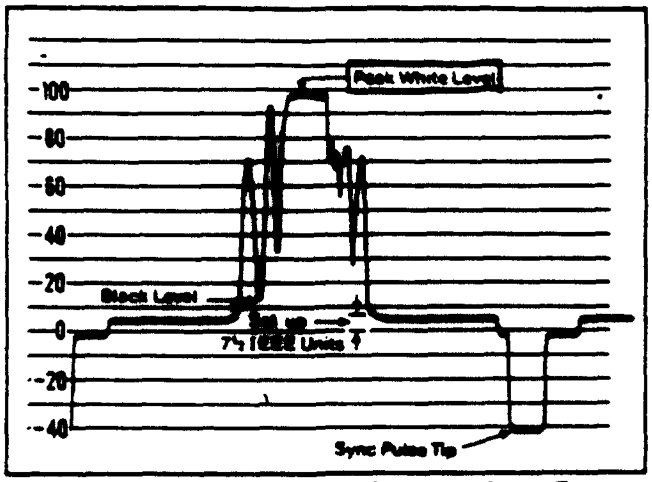
ADJUSTING VIDEO SIGNAL LEVELS

21. When video signal levels are incorrect, how are the necessary adjustments made?

A. The video signals must pass through amplifiers before being displayed on a waveform monitor. By suitable adjustment of amplifier controls, the levels in the various parts of the video signals can be made to coincide with the lines engraved on the waveform monitor graticule. Sync pulses and picture signals are routed through separate circuits before being combined to form composite video signals, and adjustments in the levels can be made independently.



A. As the electron beam in the camera tube scans an optical image, the signal level at the output of the tube rises and falls in relation to the amount (intensity) of light in the various image areas. White level is the maximum excursion of the video signal in the white direction, as observed on the waveform monitor.



Waveform Graticule Scale with Single Trace

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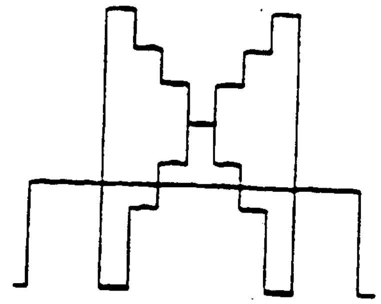
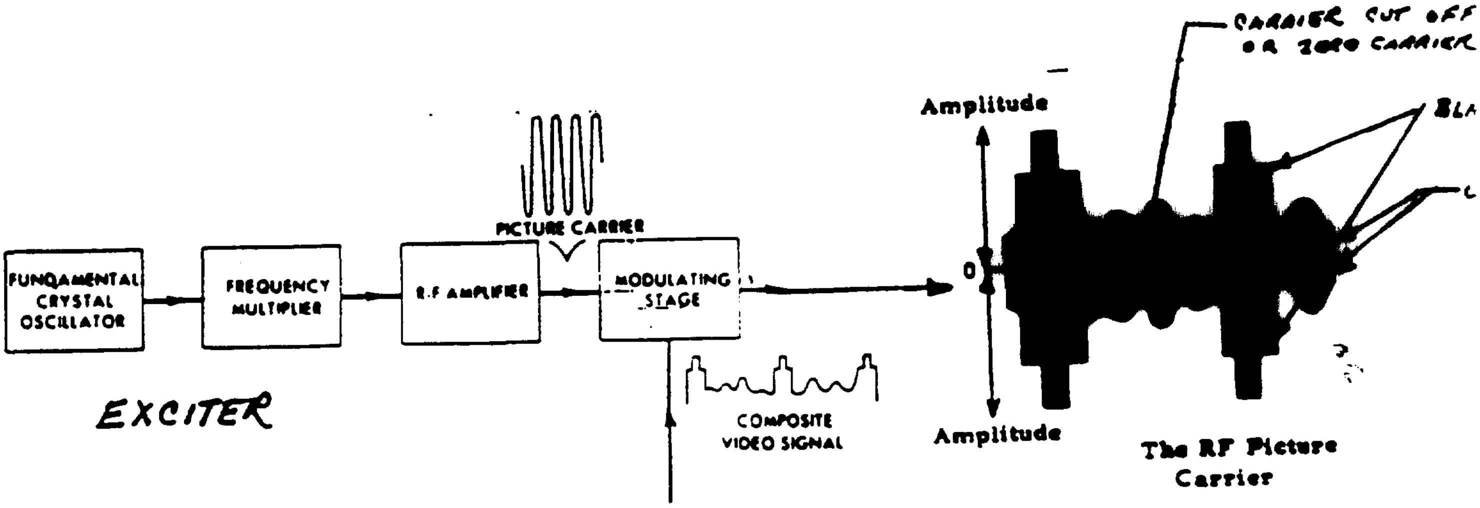
A. Normally television cameras in a studio are set up (aligned) with a gray-scale test chart that has a number of steps from black to white over a range of reflectance of approximately 40:1 — that is, the lightest step reflects 40 times more light than the black step. By suitable adjustment of camera controls, the video signal levels for the black and white steps of the chart can be made to coincide with the lines on the waveform monitor graticule, representing black and white signal levels. When the cameras are moved away from the test chart into a lighted set, the video signal levels will change if the reflectances of the lightest and darkest areas of the set are different from those of the white and black steps of the chart. The overall signal level can be raised or lowered by adjusting the camera lens aperture, or by altering the lighting on the set. (iris)



LINE

A. Transmission of video signals to a television audience involves a modulation process in which the signals are impressed on a high frequency carrier wave. The carrier is modulated in such a way that an increase in video level causes a decrease in carrier amplitude. The tips of the sync pulses occur at maximum carrier level, while white peaks in the picture portion of the signals should give a depth of modulation of 10 to 15 percent. If the white signal is allowed to rise above 100 units on the waveform monitor at the camera where the signals are being generated, improper modulation of the carrier will result, giving rise to severe buzz in the audio in some television receivers.



The RF Picture Carrier

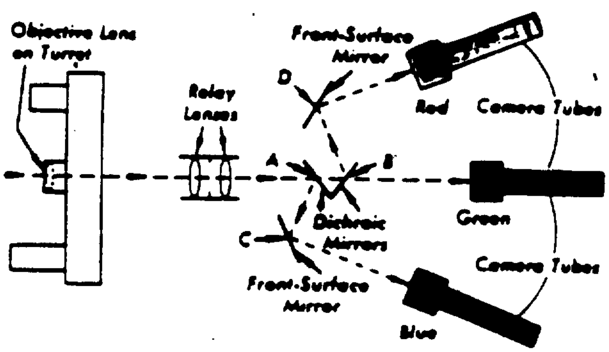
25. What other adverse effects will excessively high peak white levels give?

A. When some area of a scene or set produces peak white levels above 100 units on the waveform monitor, the camera lens aperture could be closed down a little to reduce the level. However, this will reduce the amount of light reaching the camera tube in all other image areas as well, and compression (loss of detail) in the picture shadows may result. When a performer is wearing a white shirt or dress, giving very high peak white level, closing down the camera lens will make the performer's face too dark. Another example of this kind of situation is a person posed against a window or a bright sky area. Faces should be represented on the waveform monitor scale at 50 to 80 units when the white portions of the scene fall at 100 units.

NTSC COLOR TELEVISION SYSTEM

32. How is it possible to send color pictures with two color signals when the color television camera has three color outputs — red, green, and blue?

A. The signals from the three color tubes (R, G, B) in the camera are combined in an encoder to form three new signals — a luminance or Y signal (Y does not mean "yellow" signal) and two color difference signals, R-Y and B-Y. The luminance signal is obtained by combining in the encoder the R, G, and B signals in proportions of 30 units of R, 59 units of G, and 11 units of B. By subtracting the luminance component from the R and B signals, only coloring infomation (chrominance) remains. The R-Y and B-Y signals could be transmitted along with the Y signal and produce color pictures on home receivers, but to obtain better reproduction of colors, modifications of the R-Y and B-Y signals are employed, known as the I and Q signals. These three signals — Y, I, and Q — contain all the information necessary to give color pictures.

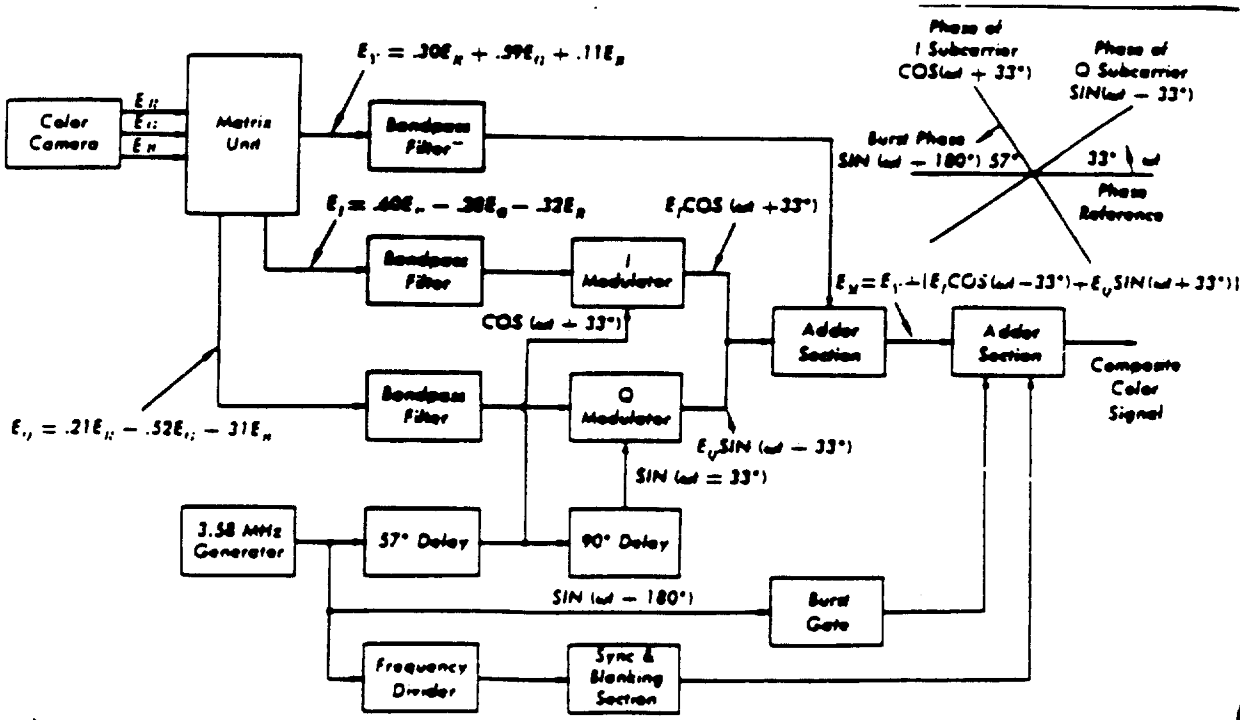


33. How are the I and Q signals combined with the Y signal?

A. The luminance (Y) signal is similar to the signal from a monochrome television camera, containing detail and brightness difference information, and is transmitted in much the same way as black-and-white television pictures. In the modulation process, the frequencies representing the luminance signal and the synchronizing pulses occur in clusters or bunches spread over the 4.25 MHz band, with spaces between them. The chrominance (color) information is fitted into these spaces by modulating a separate subcarrier frequency of 3.58 MHz, the Q signal being 90 degrees out of phase with the I signal.

34. What is the significance of the letters I and Q?

A. These letters are used to identify the two chrominance signals in the NTSC system, and are shifted in phase relative to the color difference signals, R-Y and B-Y. Both the R-Y/B-Y and I/Q signals are 90 degrees apart, but the I and Q signals are shifted 33 degrees in a counterclockwise direction. These relationships can be shown on a chromaticity diagram or on a vectorscope, with colors from red to blue-green on the R-Y axis, and blue to green-yellow on the B-Y axis. Moving these axes to the I and Q positions makes colors from orange to cyan appear on the I axis and from magenta to yellow on the Q axis. Better reproduction of colors such as flesh tones can be achieved with the I and Q signals in these phase relationships, since flesh tones fall on the I axis.



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35. What is a vectorscope?

A. A vectorscope is a special type of oscilloscope for displaying color phase relationships relative to the phase reference. The vectorscope provides a means for showing the circular vector diagram on which each color can be identified by comparison with the phase reference in degrees of rotation.

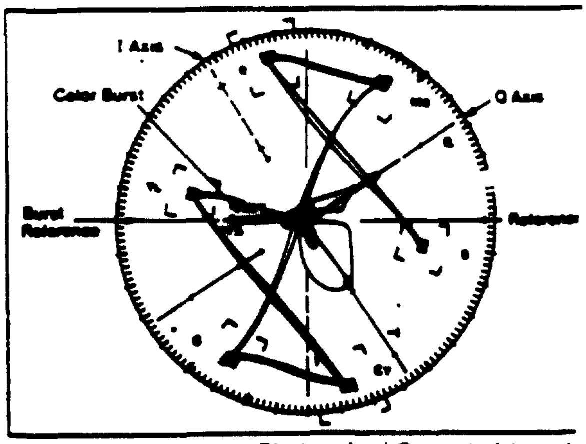


FIGURE 6 Vectorscope Display of the Correctly Adjusted Color Bar Signal

29. What is a television channel?

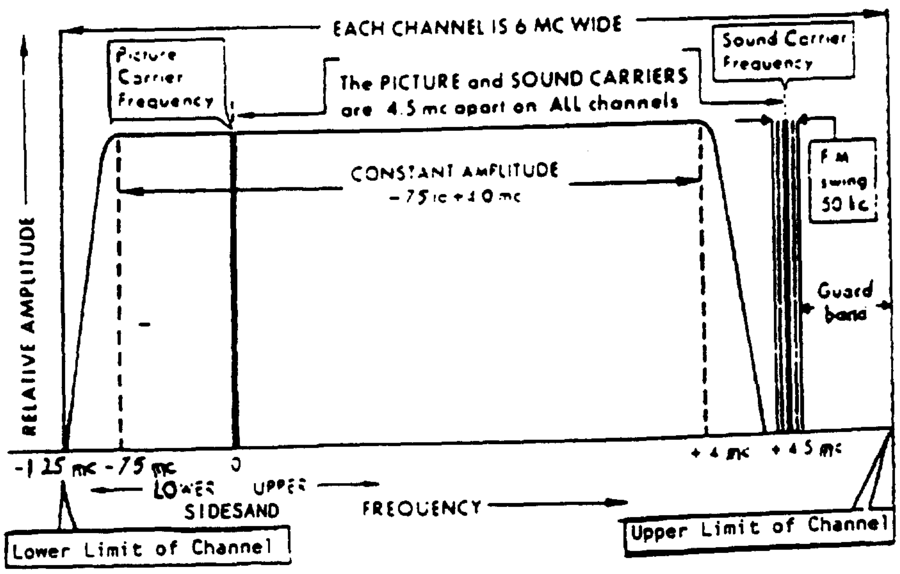
A. Television in North America has been allocated bands in the radio frequency spectrum 6 MHz in width. The two VHF (very high frequency) bands are located between 54 and 216 MHz. In each 6 MHz band, all of the information necessary for reproducing television pictures can be transmitted. These bands are known as channels, and receivers are designed to switch in steps from one VHF channel to another (channels 2 to 13). Continuous tuning is employed in the UHF (ultra high frequency) bands (channels 14 to 83) which occupy frequencies from 470 to 884 MHz.

VHF	
Channel	Frequency limits
2	54-60
3	60-66
4	66-72
5	76-82
6	82-88
7	174-180
8	180-186
9	186-192
10	192-198
11	198-204
12	204-210
13	210-216

UHF	
Channel	Frequency limits
14	470-476
15	476-482
16	482-488
17	488-494
18	494-500
19	500-506
20	506-512
21	512-518
22	518-524
23	524-530
24	530-536
25	536-542
26	542-548
27	548-554
28	554-560
29	560-566
30	566-572
31	572-578
32	578-584
33	584-590
34	590-596

UHF	
Channel	Frequency limits
35	596-602
36	602-608
37	608-614
38	614-620
39	620-626
40	626-632
41	632-638
42	638-644
43	644-650
44	650-656
45	656-662
46	662-668
47	668-674
48	674-680
49	680-686
50	686-692
51	692-698
52	698-704
53	704-710
54	710-716
55	716-722
56	722-728
57	728-734
58	734-740
59	740-746
60	746-752
61	752-758
62	758-764
63	764-770
64	770-776
65	776-782
66	782-788
67	788-794
68	794-800
69	800-806
70	806-812
71	812-818
72	818-824

U[illegible]	
Channel	[illegible]
73	[illegible]
74	[illegible]
75	[illegible]
76	[illegible]
77	[illegible]
78	[illegible]
79	[illegible]
80	[illegible]
81	[illegible]
82	[illegible]
83	[illegible]



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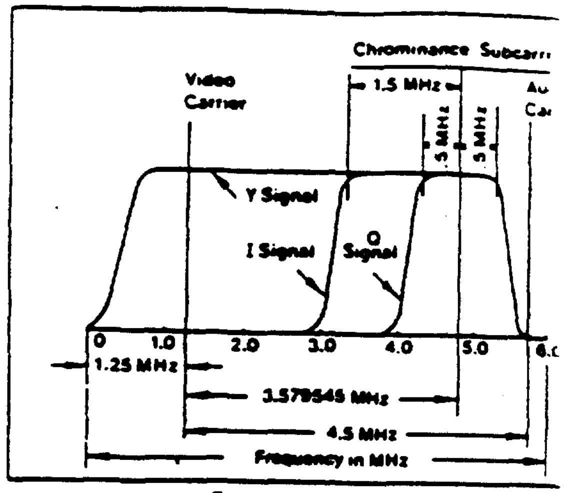
30. How is the program sound transmitted?

A. The video signals occupy a bandwidth in each transmission channel of 4.25 MHz above the lower end of each channel. At the upper end of each channel, there is a space 0.75 MHz in width set aside for the sound. The sound is transmitted by frequency modulation (FM). In the receiver the sound portion of the incoming signals is separated from the video, amplified, and fed to the loudspeaker.

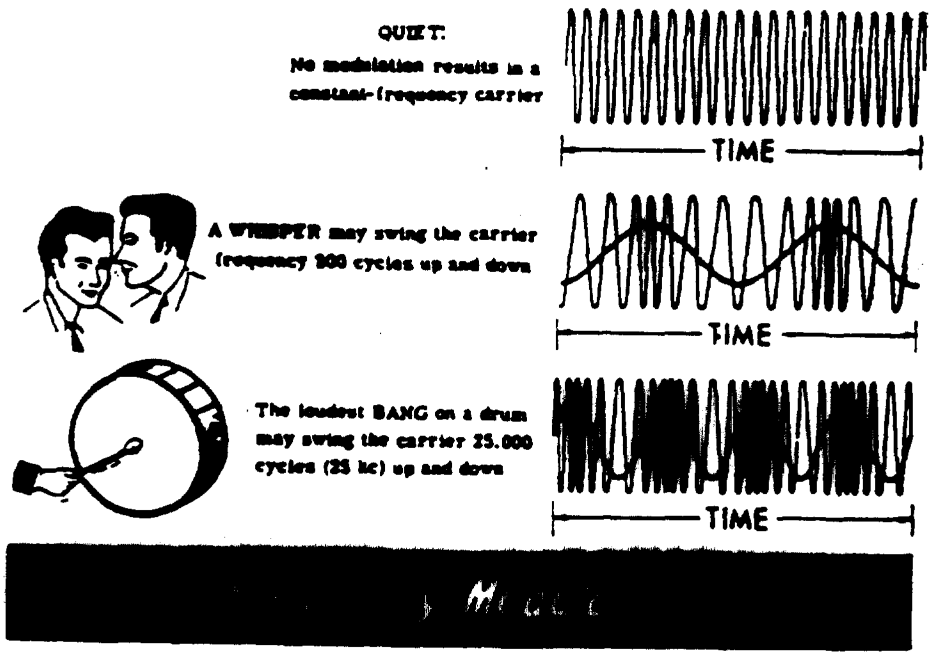


Frequency Distribution in a 6 MH Television Channel

THE SOUND SIGNAL

Producing the Frequency-Modulated Sound Carrier

A very simple example will illustrate the special language that is related to frequency modulation. Assume a TV channel 5 signal. Its sound carrier frequency allocation is 81.75 mc. In the *absence of any modulation* this radiated sound carrier has the constant or "resting" frequency of 81.75 mc.



The change in carrier frequency during frequency modulation is known as frequency deviation. When the frequency increases above the resting frequency it is known as positive deviation; when the frequency decreases below the resting frequency it is called negative deviation. The change in frequency is also called *swing*. If, for instance, a whisper at the input to the sound system results in a carrier frequency change of 200 cycles above and below the stated 81.75 mc, the frequency of the carrier swings 200 cycles in each direction, or has a total swing of 400 cycles from 81.7498 mc to 81.7502 mc.

On the other hand a sound loud enough to produce 100% modulation of the frequency-modulated carrier would, according to American standards, raise and lower the frequency by 25,000 cycles (25 kc)—an overall swing of 50 kc. The channel 5 sound carrier with a resting frequency of 81.75 mc would then have a low-frequency limit of 81.750 − .025 mc or 81.725 mc and a high-frequency limit of 81.750 + .025 mc or 81.775 mc.

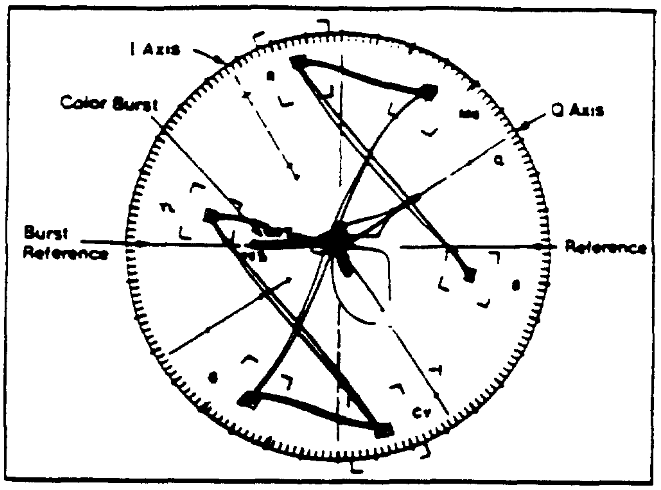


FIGURE 6 Vectorscope Display of the Correctly Adjusted Color Bar Signal

36. How are green colors reproduced in a system using only two color signals?

A. The luminance signal (Y) is obtained by combining red, green and blue signals from the color camera, and therefore *contains* green information. The I and Q signals are made up of specific proportions of R-Y and B-Y. At the receiver, red, green, and blue signals are *derived* in a decoder by combining the I, Q, and Y signals in the proper proportions.

37. It is often said that the NTSC system is phase dependent. What does this mean?

A. Color information is transmitted in the NTSC system by means of a subcarrier that is doubly modulated by the I and Q signals. The subcarrier is a continuous sine wave at a frequency of 3.58 MHz and is located near the upper end of the video frequency band. The two modulating signals are applied to the subcarrier with a phase difference of 90 degrees, so that the signal actually transmitted is the vector sum of the two signals. As the color being transmitted changes, the vectors rotate, indicating the degree of phase shift that is taking place. Every color within the range of the system is represented by a phase difference relative to the reference for the system.

THE COLOR SUBCARRIER

38. What is the color burst?

A. The color burst consists of a few cycles of the chrominance subcarrier included in the composite video signal in a space immediately preceding each horizontal line scan. As it provides the phase reference of the system at the receiver, the color burst must be very carefully controlled by the transmitting station. When the chrominance subcarrier is being modulated, the subcarrier frequency is canceled out leaving sidebands containing the chrominance information. At the receiver there is an oscillator running at approximately the subcarrier frequency of 3.58 MHz. This oscillator is synchronized with the subcarrier generator at the transmitting station by means of the color burst, thus providing the essential subcarrier reference frequency in the receiver.

39. What is the purpose of the color bar test pattern?

A. The color bar pattern is used for checking and adjusting encoders, color picture monitors, and receivers. It consists of vertical bars of the three primary colors — red, green, and blue, and the three complementary colors — cyan, magenta, and yellow — as well as white and black levels. The colors are arranged in a descending sequence of signal levels, from left to right, as seen on a picture monitor or receiver. When the chrominance portion of the composite video signal is removed, the remaining luminance signal gives a stepped gray scale. To obtain this result, the colors are arranged in the following order: white, yellow, cyan, green, magenta, red, blue and black.

40. How is the color bar pattern obtained?

A. It is not necessary to set up a camera to scan a color bar chart. The test pattern can be produced much more easily and with greater accuracy by means of an electronic device called a color bar generator. The generator puts out a signal in which the phase of the 3.58 MHz reference frequency is shifted in a time delay sequence. For example, a phase shift of 12 degrees produces a yellow color, while red is obtained by shifting the phase 76.5 degrees. By shifting the phase in a fixed time sequence, a pattern of vertical bars of the required colors can be generated.

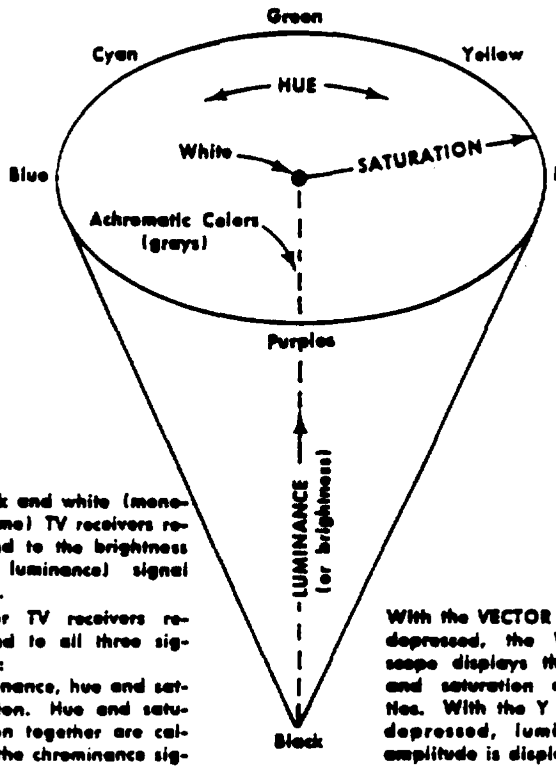
41. How is the chrominance removed from the luminance signal?

A. The chrominance signal occupies a portion of the video frequency band near the upper end, around the subcarrier frequency of 3.58 MHz. The luminance signal occupies the entire frequency band of 4.25 MHz. The chrominance signal can be separated from the luminance signal by making use of a frequency limiting filter network.

COLOR-MONOCHROME COMPATIBILITY CONSIDERATIONS

42. What happens when color signals are fed into a monochrome receiver?

A. Monochrome receivers respond to the luminance portion of the color signals only, providing pictures that have an appearance similar to those from a monochrome camera.

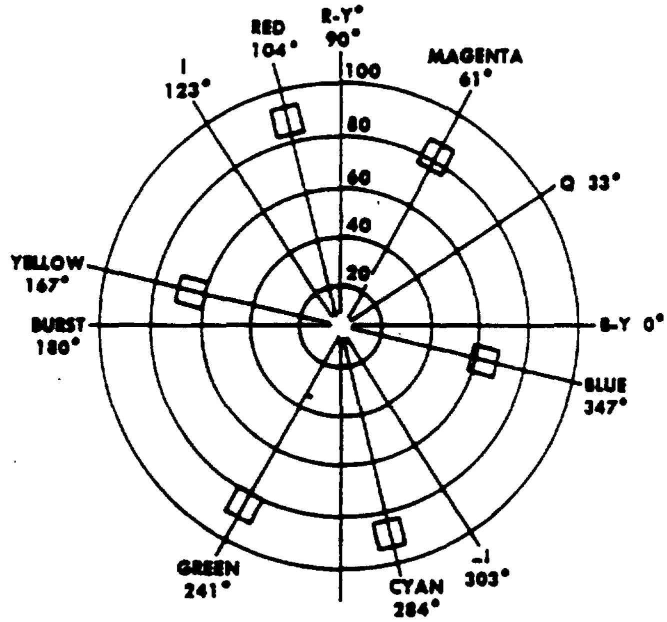


Black and white (monochrome) TV receivers respond to the brightness (or luminance) signal only.

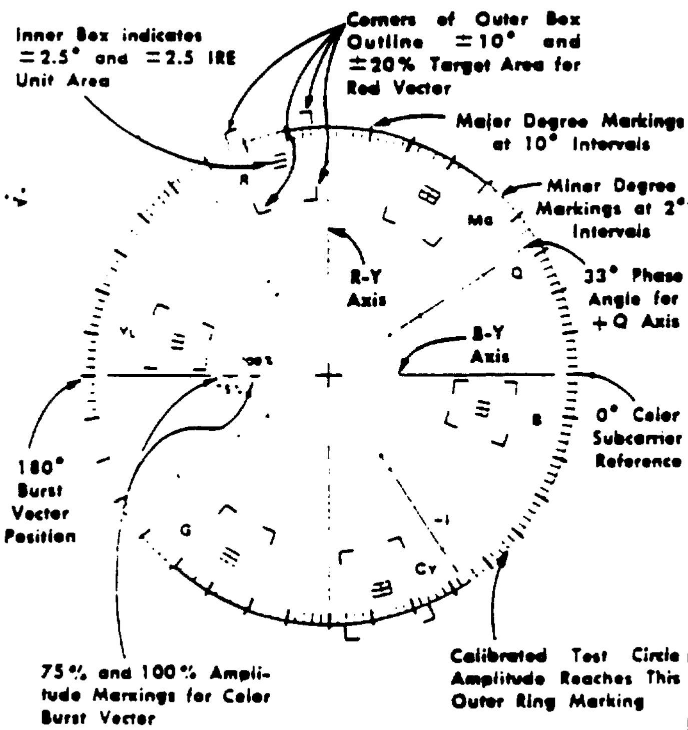
Color TV receivers respond to all three signals: Luminance, hue and saturation. Hue and saturation together are called the chrominance signal.

With the VECTOR button depressed, the Vectorscope displays the hue and saturation quantities. With the Y button depressed, luminance amplitude is displayed.

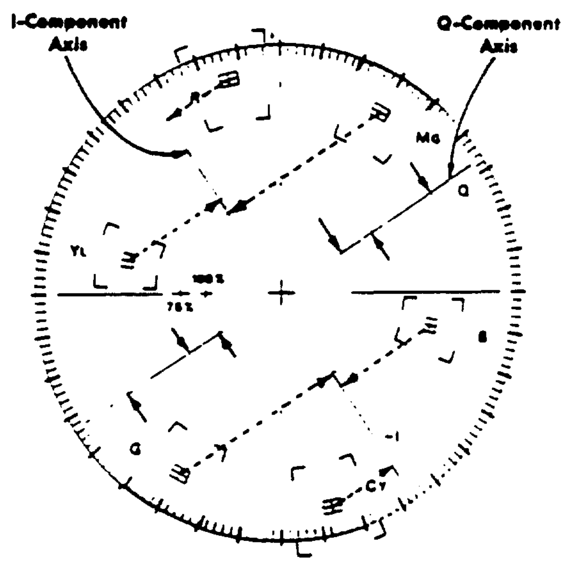
(A) Conical three-dimensional representation of color concepts.



(B) Standard color-phase vector diagram showing vector relationship among chrominance components.



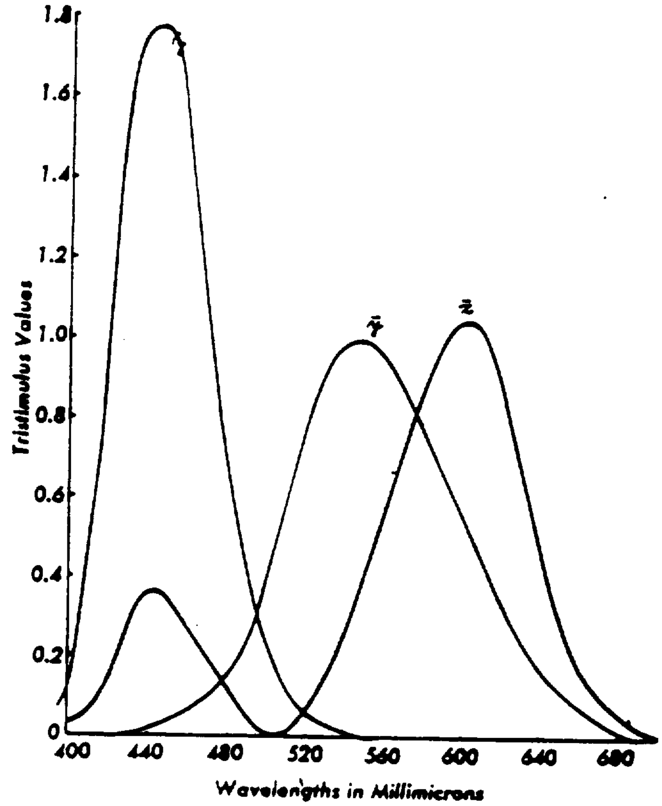
(C) Vector (internal) graticule on the Type R520 with color vector and phase markings defined to aid in interpreting vector displays.

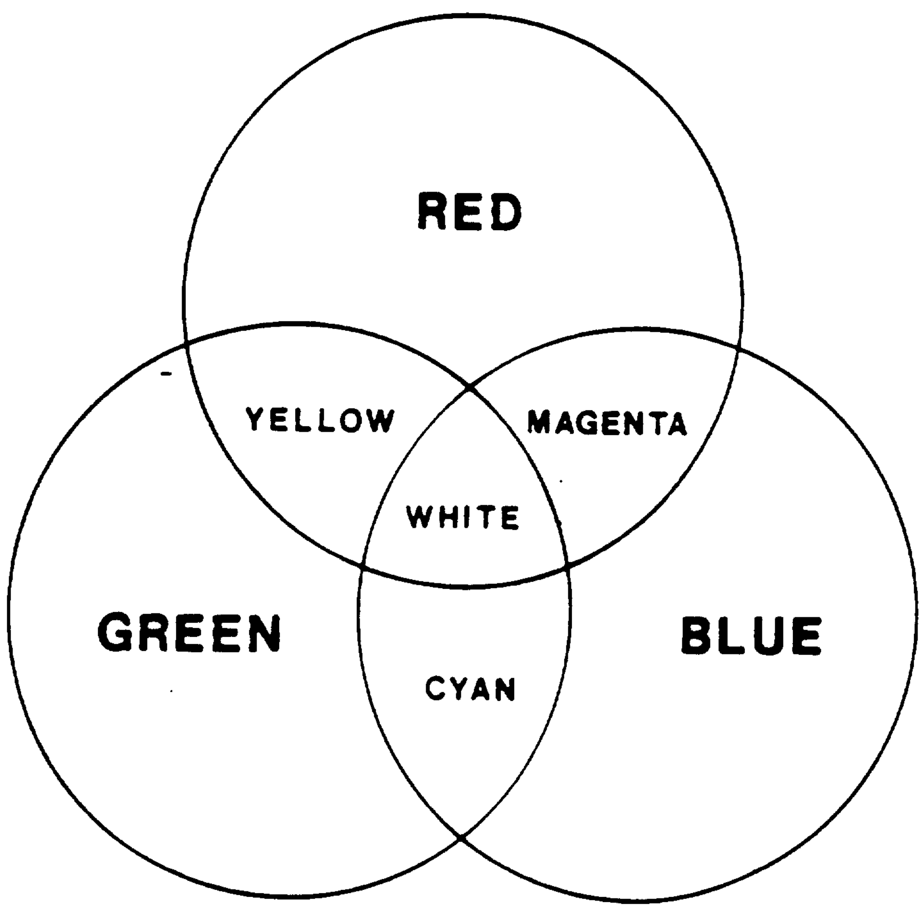


Dashed line with arrow associates the color vectors with the I-axis markings. If Q component of the signal is absent, linear color vectors will move to their associated markings on the I-axis.

Short arrows along the Q-axis are intended to show relationship between Q-axis markings and the associated color vectors. If I component in the signal is absent, linear color vector points will appear at the appropriate marks along the Q axis.

(D) Vector graticule on the Type R520 showing purpose of I and Q axis markings.


1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Tristimulus Values
400
440
480
520
560
600
640
680
Wavelengths in Millimicrons


RED
YELLOW
MAGENTA
WHITE
GREEN
BLUE
CYAN

05775

219

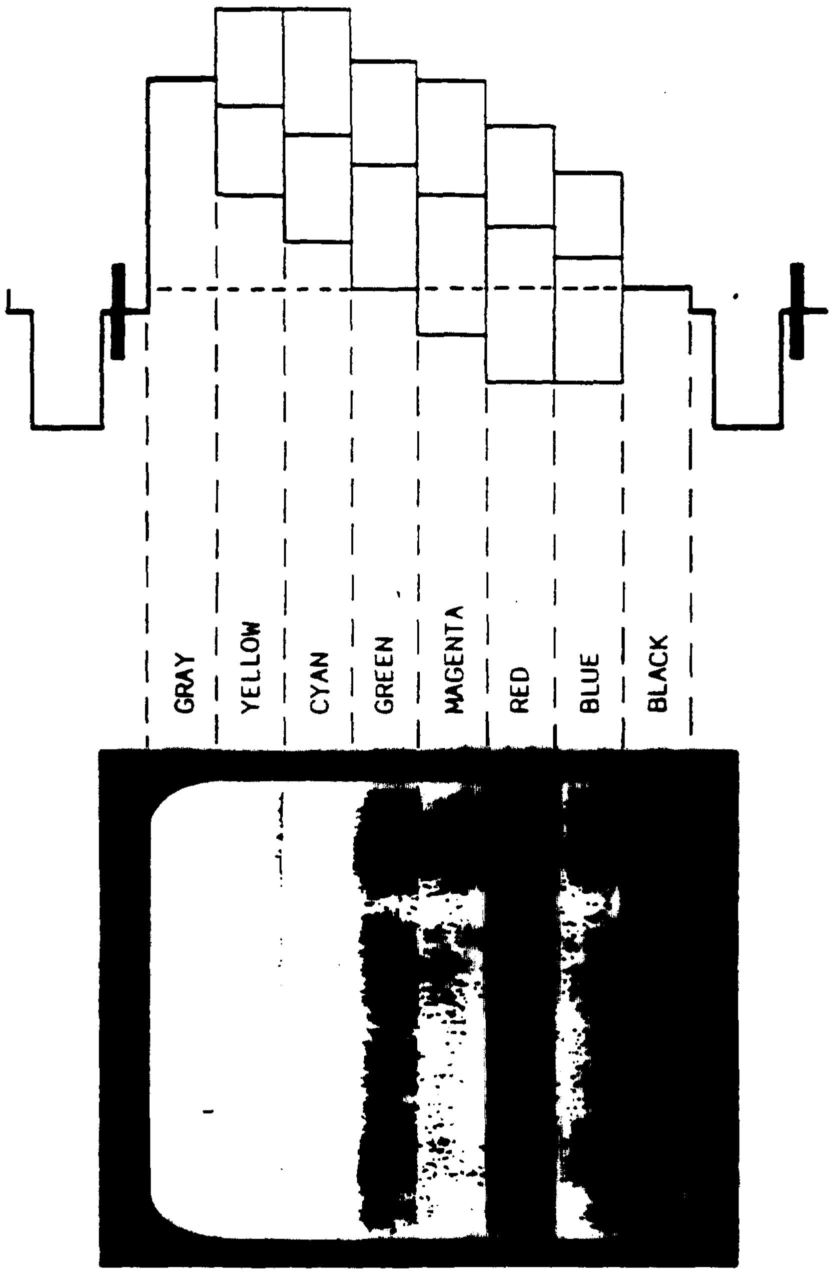


Fig. 10-1. Color-bar test waveform.

43. How does a color receiver respond to monochrome signals?

A. In a color receiver, the luminance portion of color signals is fed to all three electron guns in the picture tube, along with the three color signals — red, green, and blue. The luminance signal provides the brightness variations in the picture display, while the color signals affect the intensity of the three beams differentially, producing colors in the pictures. When a monochrome signal is fed into a color receiver, the three guns receive luminance information only and act together to produce pictures without color.

44. What is done to prevent unbalance in a color receiver that would give tinted pictures from monochrome signals?

A. During the reception of monochrome signals, the chrominance channel is disabled by what is known as the color-killer circuit. This allows only the luminance signal to reach the picture tube. Signals are prevented from passing through the chrominance channel by electrically biasing to cut off one or more stages in this channel.

45. How does the receiver distinguish between color signals from black-and-white objects, such as line drawings or newspaper clippings, and the signals from a monochrome camera?

A. Composite color signals include several cycles of subcarrier frequency called color burst, in a space following the horizontal sync pulse. The presence of the color burst indicates that color signals are being received.

46. How does the color television system reproduce black-and-white objects?

A. When the color subcarrier is being modulated by the signals from a color camera, the output of the modulator circuit falls to zero when no color is present. Since there is no chrominance signal at the receiver in this case only the luminance signal would be fed to the three guns in the picture tube. However, if the color camera is not perfectly balanced to a neutral condition, and some subcarrier appears in the transmitted signals, the picture in the color receiver will not be neutral in appearance. When black-and-white film is being transmitted, it is customary for stations to switch off the color burst to avoid the effects of camera unbalance.

ADJUSTING COLOR BALANCE IN TELEVISION CAMERAS

47. What is meant by balancing a color camera to a neutral condition?

A. The light entering the color camera through the lens is split into red, green, and blue components by means of color filters. As the cameras are usually aligned (balanced) with a gray-scale test chart, filters are selected that will give a neutral reproduction of the chart when the video waveforms from the three camera tubes have the same amplitude. In the encoder, the luminance signal is derived by combining 30 units of the red signal, 59 units of the green signal, and 11 units of the blue signal. When the three color signals from the camera have the same amplitude, there is no chrominance output from the encoder — that is, the subcarrier falls to zero, or disappears — and the neutral balance is maintained in transmission to home receivers.

48. What happens when a color camera balanced for studio (tungsten) light is taken outdoors?

A. Daylight has more blue energy than tungsten light. When a camera balanced for tungsten light is moved out of the studio for an outdoor scene, the blue waveform from a gray-scale test chart will be higher in amplitude than the green and red waveforms. To compensate for these changed conditions, the camera has to be rebalanced, reducing the signal level in the blue channel, and perhaps also increasing the green and red signal levels.

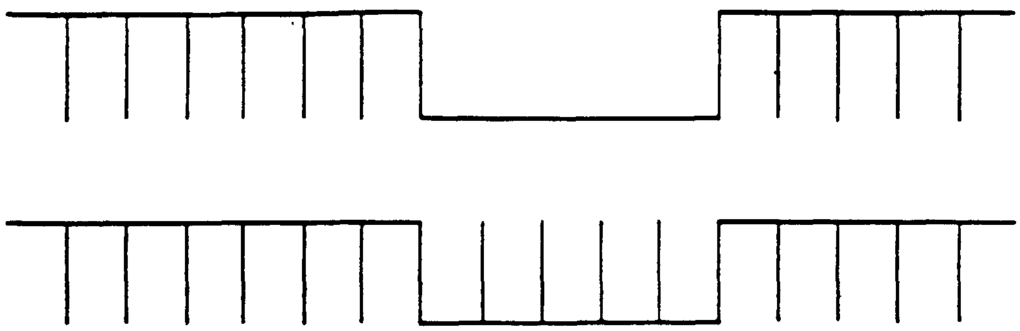
49. How are the signal levels from the color camera raised or lowered?

A. When the overall amount of light entering the camera changes, the resulting video waveforms (or signal levels) can be raised or lowered by altering the opening in the camera lens. If, however, the spectral energy distribution of the light changes, as in going from a studio illuminated with tungsten light to an outdoor scene, the camera can be rebalanced by placing a suitable color filter in front of the lens. For example, a yellow filter absorbs blue light, and this would reduce the level of the signal from the blue camera tube.

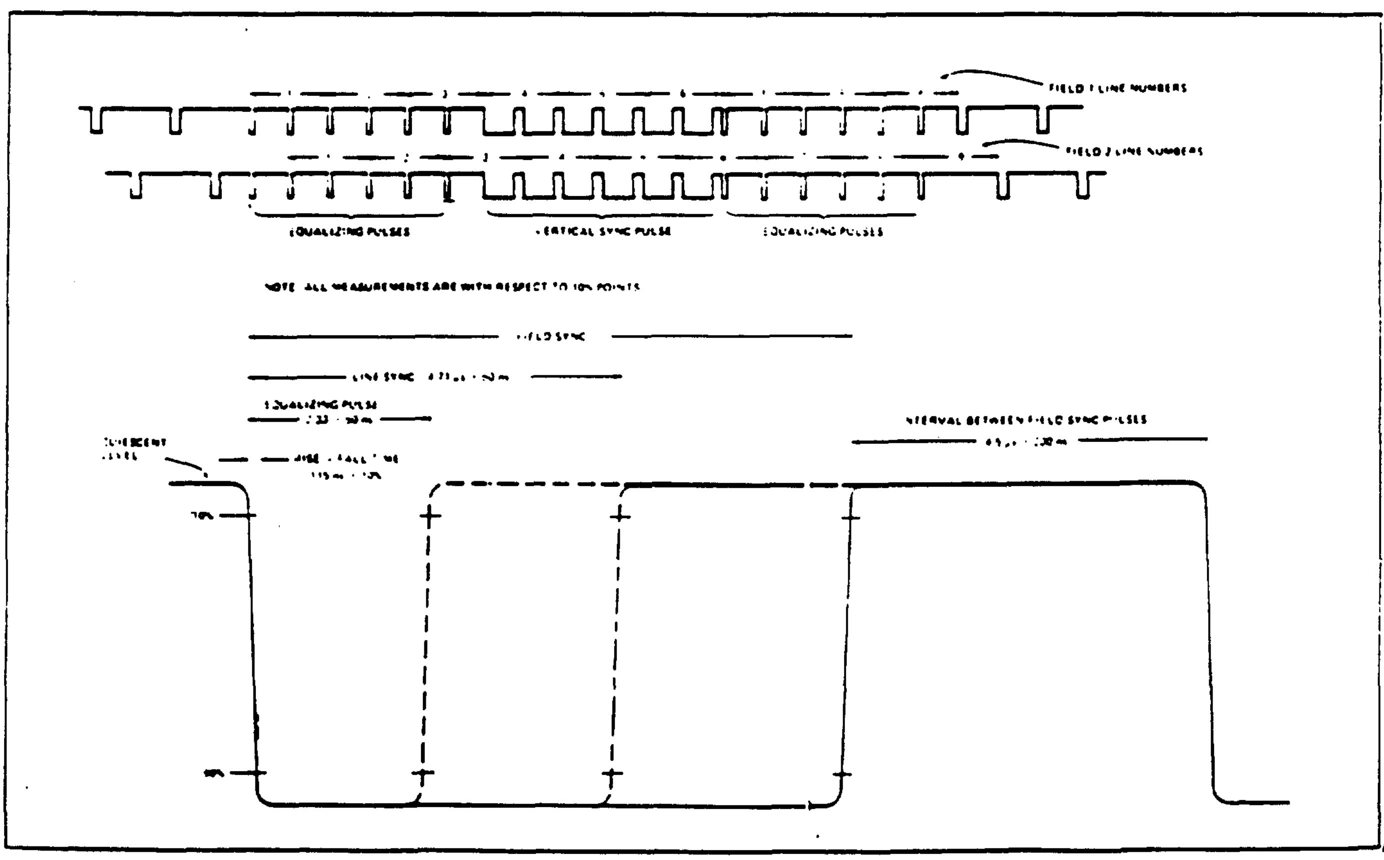
50. How are the separation filters in a color camera selected?

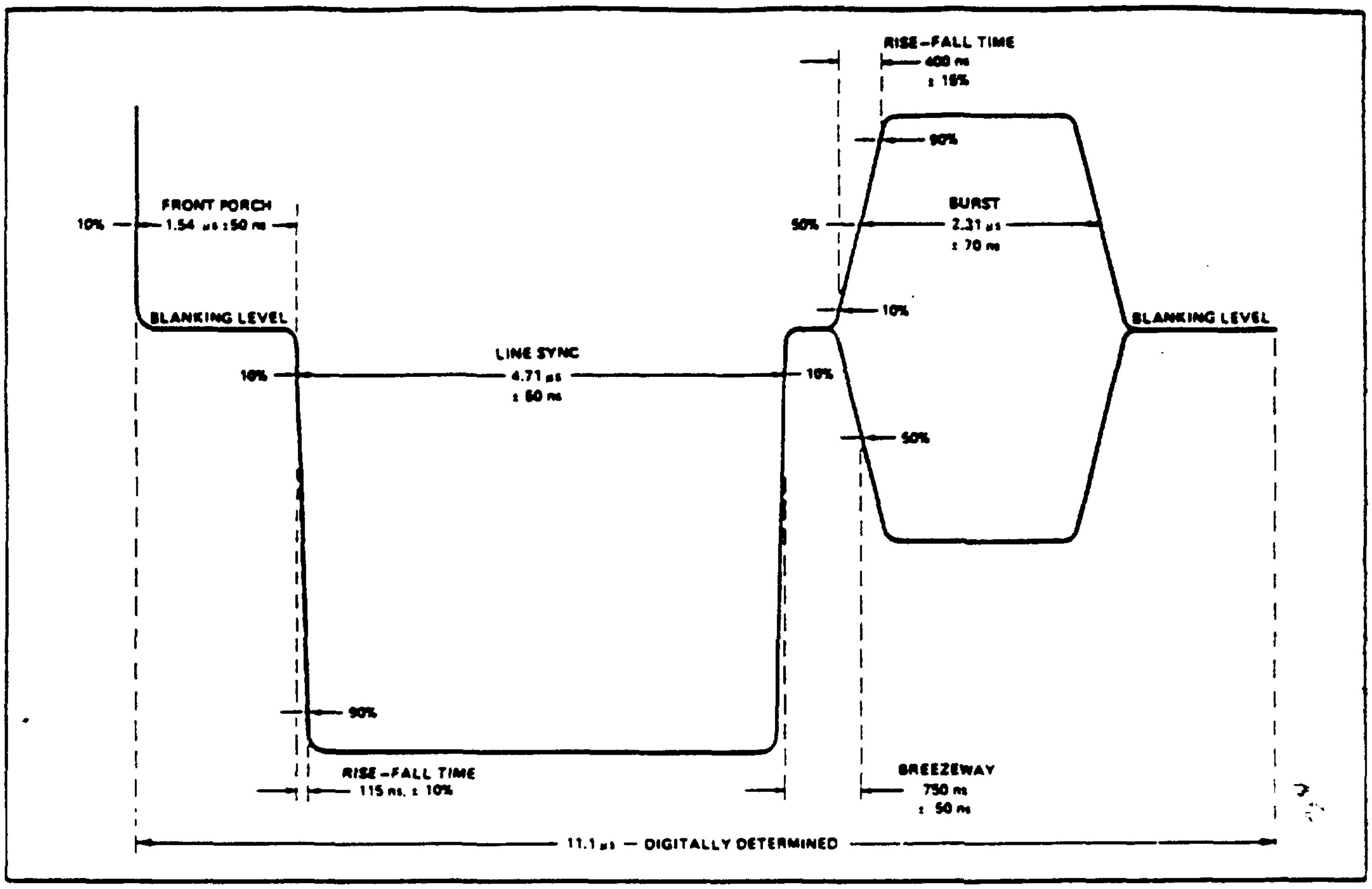
A. When the National Television Systems Committee (NTSC) was preparing specifications for color television in the early 1950s, three primary colors were adopted with peaks at 610 nanometers for the red, 540 for the green, and 470 for the blue. These colors were selected to complement the color phosphors available for use in picture tubes. In practice, the designers of television cameras, in order to obtain the most pleasing pictures, select filters with passbands that may be slightly different from the NTSC specifications.

VERTICAL SYNC

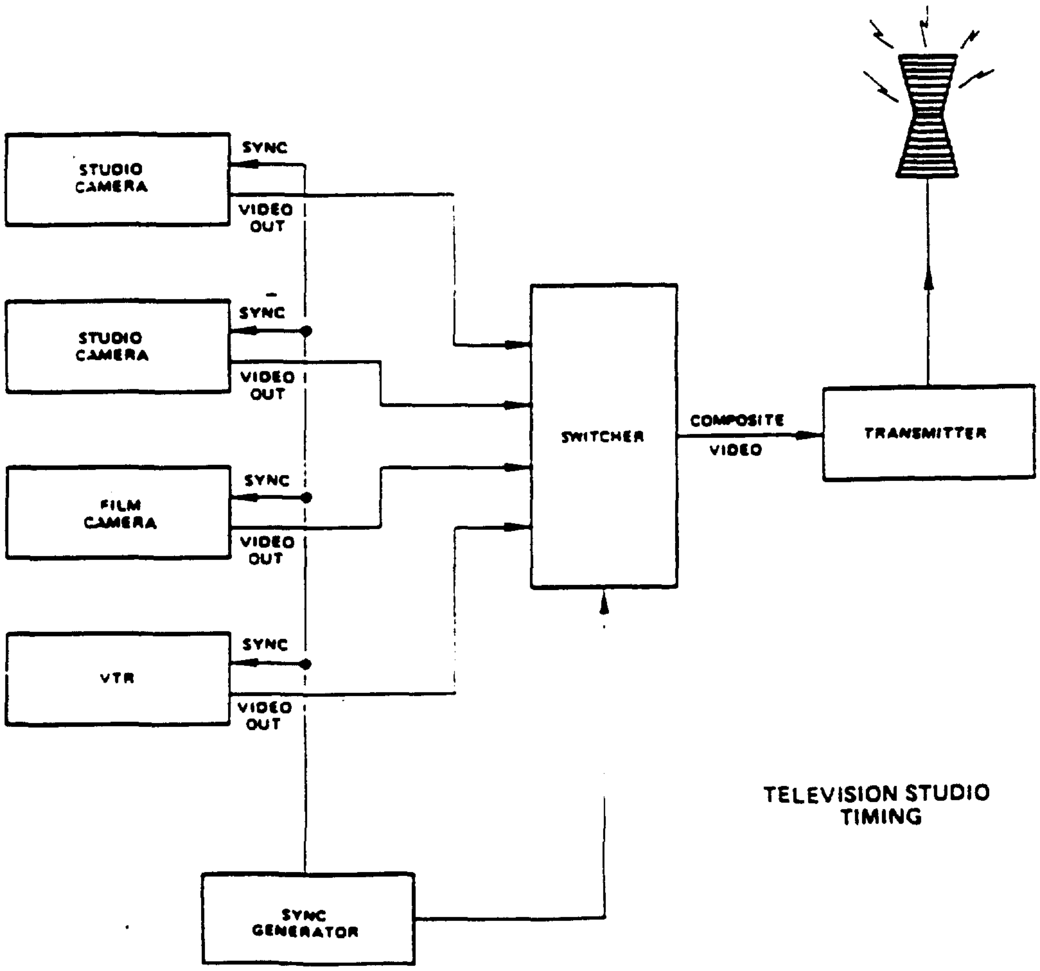


VERTICAL DEFLECTION





Horizontal blanking details.



TELEVISION STUDIO
TIMING

0577

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